AD-A063 038 WOODWARD-CLYDE CONSULTANTS PLYMOUTH MEETING PA F/G 13/2

NATIONAL DAM SAFETY PROGRAM. LAKE ONTELAUNEE DAM (NATIONAL I.D.--ETC(U)

MAY 78 J H FREDERICK, W S GARDNER DACW31-78-C-0048

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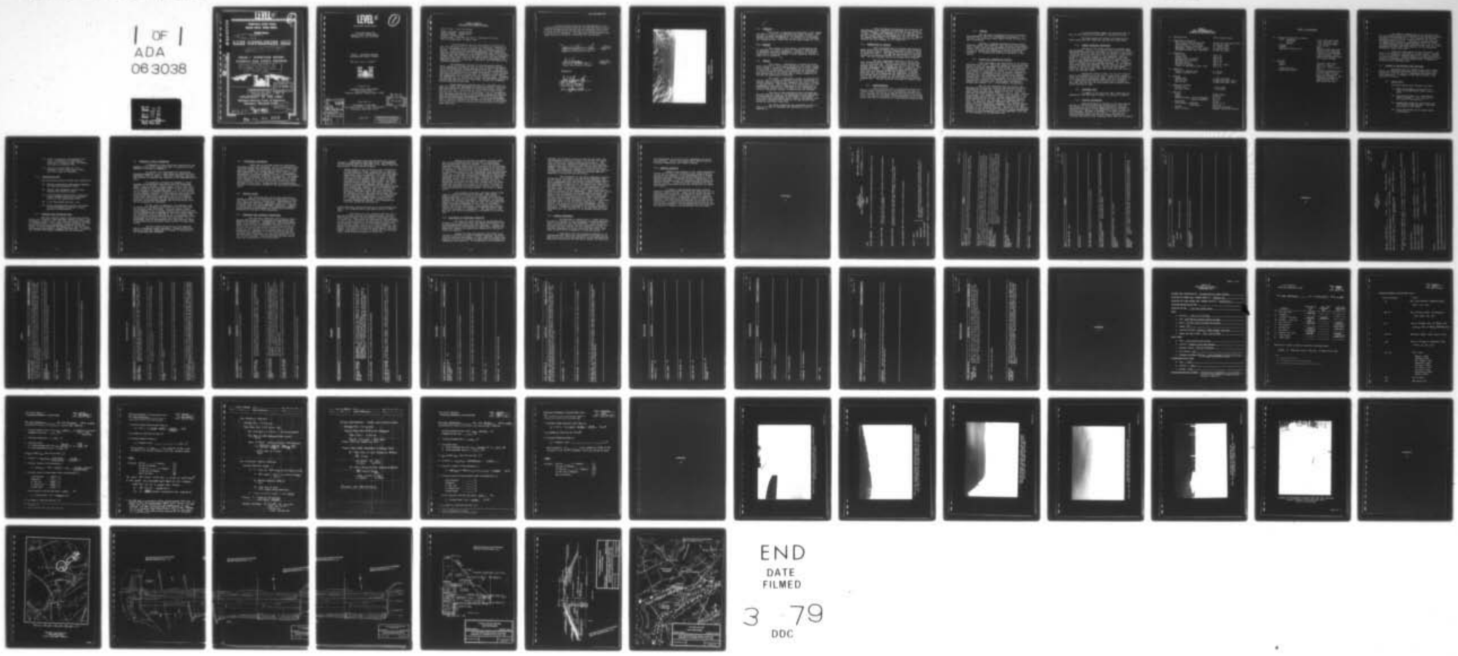

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LEVEL II

SCHUYLKILL RIVER BASIN
MAIDEN CREEK, BERKS COUNTY

PENNSYLVANIA

(10) John H. /Frederick, Jr.
William S. /Gardner

LAKE ONTELAUNEE DAM

(15) DACW31-78-C-0048

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

(6) National Dam Safety Program. Lake Ontelaunee Dam (National I.D. Number PA-00709), Schuylkill River Basin, Maiden Creek, Berks County, Pennsylvania. Phase I Inspection Report.

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LEVEL II

(1)

SCHUYLKILL RIVER BASIN

LAKE ONTELAUNEE DAM
BERKS COUNTY, PENNSYLVANIA
NATIONAL I.D. NO. PA 00709

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DACW31-78-C-0048

Prepared by:

WOODWARD-CLYDE CONSULTANTS
5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

May 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lake Ontelaunee

County Located: Berks County
State Located: Pennsylvania
Stream: Maiden Creek
Coordinates: Latitude 40° 26.9' Longitude 75° 55.8'
Date of Inspection: 4 April 1978

Lake Ontelaunee Dam has functioned satisfactorily for over 40 years and, at the time of inspection, appeared to be in a reasonable state of repair and, in general, good condition. A review of the available hydraulic and hydrologic data for this structure and the supplemental data used to determine spillway adequacy in accordance with Phase I guidelines reveals that the structure would barely pass half the probable maximum flood (PMF), but not the PMF without overtopping the embankment section of the dam. Therefore, the spillway is considered inadequate.

The embankment section of the dam exists mainly above normal pool elevation and, as such, functions primarily as an emergency dike during periods of peak flow. The combination of infrequent periodic inundation of the embankment area and the high potential for sinkhole development in the soluable limestone foundation rock may lead to collapse of portions of the embankment, as occurred during the flood of 1935. Although it probably was not the design intent, the embankment section of the dam may well serve as a "fuse dike" during low frequency storms approaching half PMF.

Since stability analyses were not available for review for either the embankment or spillway section, these computations should be furnished for flows approaching one-half PMF and full PMF. This analysis should also include items delineated in Section 10.0 of this report. It is recommended that detailed evaluations of the spillway adequacy be made and that the potential for overtopping and risk of failure associated with overtopping be assessed. It is also recommended that a stability analysis of the dam and spillway be performed, for all operating conditions considering the ongoing sinkhole development under normal pool.

Considering the potential for overtopping, it is recommended that a definite plan for around-the-clock surveillance be implemented during periods of unusually heavy rains. A formal warning system should also be developed for use in the event of an emergency. The operation and maintenance procedure should be formally documented and implemented.

John H. Frederick, Jr., P.E. — 5/31/78
Maryland Registration 7301 — Date

W S Gardner
William S. Gardner, P.E. — 5/31/78
Penna. Registration 004302E — Date

APPROVED BY:

JOHN H. KENWORTHY
LTC, Corps of Engineers
Acting District Engineer

DATE: 14 June 1978

OVERVIEW

LAKE ONTELAUNEE DAM

ABSTRACT

1.0 AUTHORITY

The Phase I investigation described in this report was made as a part of the National Dam Safety Program. This program is being implemented by the Secretary of the Army, through the Corps of Engineers, in response to the National Dam Inspection Act, Public Law 92-367, dated August 8, 1972.

~~2.0 PURPOSE~~

The purpose of this Phase I investigation was to determine, by visual inspection, whether a need exists to implement emergency measures to counteract an existing condition or conditions deemed to pose immediate hazards to human life or property.

ABSTRACT

3.0 GENERAL

This Phase I investigation followed the procedures outlined in "Recommended Guidelines for Safety Inspection of Dams", issued by the Department of the Army, Office of the Chief of Engineers. The investigation consisted of a review of readily available engineering and operational data pertaining to the project and a visual inspection of the dam and appurtenant structures.

The Phase I investigation seeks to evaluate the risk of such a failure occurring in the near future and to suggest remedial measures for lessening the risk of failure in the long-term. The product of this investigation is the assessment of the general condition of the project and a professional opinion as to the need for any emergency measures or additional studies, investigation and analyses.

The bulk of the engineering data reviewed was derived from the files of the Pennsylvania State Department of Environmental Resources in Harrisburg, Pennsylvania. This agency has maintained active files on the design, construction, operation and review of all dam projects permitted by the State since 1914.

The field inspection was performed on April 4, 1978, by a team of engineers and geologists listed in Appendix B.

Local information concerning the operation and maintenance of the facility was provided by Mr. George C. Patton, Engineer, representing the City of Reading, Bureau of Water. Additional information was also provided by Messrs. Howard Koch and Dan Kennedy of the City of Reading. Mr. Edward Leonardzak, City Councilman for the City of Reading was also present at the inspection.

4.0 DESCRIPTION OF PROJECT

Lake Ontelaunee Dam is situated approximately seven miles north of Reading, Pennsylvania, and 2.8 miles above Maiden Creek's confluence with the Schuylkill River, as shown on Plate 1. The dam was constructed in 1926 and raised to its existing height in 1935 by the City of Reading. The dam impounds the City's primary water supply.

The main impounding structure is 543.5 feet long concrete gravity dam with a full crest spillway section at elevation 294. The concrete section of the dam extends from the right abutment and joins a 2834 ft. long earthen embankment. The embankment has a minimum crest elevation of 304.5, is primarily situated above normal pool level and extends to the left abutment. Pertinent technical data and dimensions are summarized on Table 1. An overview photo and plan of the concrete spillway portion of the dam are shown in the frontispiece and Plate 2, respectively. Typical sections are given in Plates 3 and 4.

4.1 CLASSIFICATION

Lake Ontelaunee Dam is classified according to Federal (OCE) Guidelines as an intermediate size dam, by virtue of both the height of dam and maximum storage capacity. Because failure would potentially result in the loss of life to several residents living downstream along Maiden Creek, the dam is classified as a High Hazard Potential dam.

4.2 PURPOSE

The facility is owned by the City of Reading and operated by the City's Engineering Department. It serves as the principal water supply source for the City and its environs.

Because it extends throughout several jurisdictional areas, the reservoir area has been consolidated into a single district for purposes of policing and conservation. The State Department of Wildlife also maintains a wildlife refuge and conservation program around the reservoir. No recreational boating or swimming is permitted.

4.3 DESIGN AND CONSTRUCTION HISTORY

This impoundment was constructed in two phases described as follows. The first phase of construction completed in 1926 was performed by the McLean Contracting Company of Baltimore, Maryland. This brought the structure to elevation 271.4 as shown on Plate 3. The second and final phase was completed in 1935 by Gannett, Eastman and Fleming, Inc., and Whiting-Turner Construction Company, who performed the earthworks and concrete construction, respectively. The files were unclear as to who designed the original structure but records for the second phase of construction indicated that the designer was Gannett, Eastman and Fleming, Inc., of Harrisburg, Pennsylvania.

The records indicated that the project was designed and constructed using the conventional state-of-the-practice of that era. During the initial filling, a major flood occurred which began at 6:00 a.m. on July 8, 1935 and continued through 12:00 p.m. July 9, 1935. During this period, 5.02 inches of rainfall were recorded at the Maiden Creek Pumping Station, located approximately 1-1/2 miles downstream of the dam, and the subsequent maximum flow over the crest was recorded to be approximately 3.3 feet. In addition, several sinkholes were reported upstream from and immediately adjacent to the earthen embankment at a point approximately 500 feet east of the east abutment of the concrete spillway. Water was also observed flowing up and out of several sinkholes located immediately adjacent to the downstream toe of the embankment just west of the sinkholes on the upstream side.

A well documented report of the nature and repair of this failure is contained in the State's files.

No other reports of unusual or alarming incidents since the 1935 flood and failure have been noted.

4.4 NORMAL OPERATING PROCEDURES

Records of the normal operating procedure were not available. However, discussions with the City's representatives indicate that the water is supplied to the City's filtration plant through three 48-inch diameter intake pipes controlled by valves located in the pumphouse, shown on Plate 2. A blow-off system is also located in the pumphouse, as an emergency drawdown system, in addition to four 36-inch pipes with control valves on the bridge. Excess water is routed over the concrete spillway. It is reported that water flows continuously over the spillway for approximately 10 months of the year. During the mid-summer months of July and August there are times when the level is below the spillway crest.

During the flood of 1935, the 48-inch blow-off pipe in the pumphouse and the four 36-inch pipes located along the spillway were fully open. Records of opening the five pipes during subsequent storms were not available. It is understood that the 48-inch pipe can be opened at any time, but the four 36-inch pipes require special mechanical devices to open.

4.5 PERTINENT DATA

A summary of the pertinent data, obtained predominantly from the State's files, is outlined in Table 1.

4.6 GEOLOGIC BACKGROUND

Lake Ontelaunee is located in the Great Valley section of the Valley and Ridge Physiographic Province. The bedrock in the reservoir area consists of carbonate formations belonging to the Beakmantown Group of Lower Ordovician age. The dam is founded in the upper section of the Rickenback Dolomite (see Plate 5). This rock is a solution-prone gray, very fine to coarse crystalline, laminated dolomite having irregular chert beds and stringers.

TABLE 1
LAKE ONTELAUNEE DAM
SUMMARY OF PERTINENT DATA

1.	Drainage Area	192.0 square miles
2.	Discharge at Dam Site	
	Max. Known Flood at Dam Site	24,000 cfs (est-June 1972)
	Outlet Works (3-48" pipes)	no rating curve
	Blow-Off Valve (1-48" pipe)	no rating curve
	Emergency Drawdown (4-36" pipes)	no rating curve
	Spillway at Max. Pool Elevation	65,000 cfs (est.)
3.	Elevations	
	Top of Dam	304.5 ft.
	Normal Pool	294.0 ft.
	Maximum Pool of Record	299.4 ft.
	Maximum Pool Possible	304.5 ft.
	Spillway Crest	294.0 ft.
	Maximum Tailwater	280.0 ft. (est.)
	Invert of Emergency Pipes (u/s)	253.0 ft.
4.	Reservoir	
	Length at Maximum Pool	4.7 miles
	Fetch at Normal Pool	0.7 mile
5.	Storage	
	Normal Pool	11,900 Acre-Feet
	Maximum Pool	10,888 Acre-Feet (est.)
	Top of Dam	10,888 Acre Feet (est.)
6.	Reservoir Surface	
	Normal Pool	1,037 Acres
	Spillway Crest	1,037 Acres
7.	Dam Data	
	Type	Rolled Earth
	Length	2,834 ft.
	Maximum Height- Above Foundation	18.5 ft.
	- Above Streambed	51.5 ft.
	Top Width	46 ft.
	Side Slopes - Upstream	2-1/2H on 1V
	- Downstream	2H on 1V
	Cutoff	Concrete Core Wall
	Grout Curtain	Single Line Grout Curtain

TABLE 1 (continued)

8. Diversion & Regulating Tunnel	
Type Emergency	4-36" Cast Iron Pipes
Blow-Off	1-48" Concrete Pipe
Normal	3-48" Concrete Pipes
Closure	Gate Valves
Access	None
Regulating Facilities	48-inch pipes are regulated in the Pumphouse located at the upstream right abutment. 4-36" pipes are regulated from the highway bridge.
9. Spillway	
Type	Concrete Ogee Crest
Length	543.5 ft. (total 507.5 ft. (minus piers)
Crest Elevation	294.0
Downstream Channel	Spillway discharges into a rock-lined stilling basin located in the original streambed. The downstream channel is approximately 150 ft. wide below the dam.

The regional bedrock dip is to the north, but due to complex folding the direction of dip changes abruptly. As shown in Photograph No. 6, rock exposures at the dam abutments strike N 70°-80° E and dip 80° to 85° south (in the downstream direction). Jointing is generally normal to bedding with strikes ranging between N 50° E to N 13° W (in the downstream direction) and with dips of 87° E, lesser northeast striking and south dipping (in the downstream direction) joints also occur.

Along the south shore of Lake Ontelaunee, just east of the spillway, outcrops of dolomite occur. Several 4 to 5 ft. diameter sinkholes about 6 ft. deep were noted in the outcrop area. These sinkholes have developed at the junction of bedding and joint planes which is typical of solution-prone carbonate rock.

5.0 SUMMARY OF ENGINEERING DATA AVAILABLE

Available data for review during this investigation was obtained from State files in Harrisburg, Pennsylvania or from the Owner's representatives during the site inspection. A summary of the data reviewed is described as follows.

5.1 DESIGN DATA

Available design data reviewed included:

(a) Application Report prepared by the State of Pennsylvania, dated June 21, 1926.

(b) Application Report for improvements, dated December 4, 1933, prepared by the State of Pennsylvania.

(c) Handwritten stability calculation for the concrete ogee spillway. Date and calculator is not known.

(d) Fifty blueprints of the second phase construction.

(e) Corps of Engineers, Philadelphia District, "Synthetic Unit Hydrograph Analysis for Maiden Creek", 161 square mile area, 2 November 1958.

(f) "Special Projects Memo No. 165, Schuylkill River Basin Model Study", May 1976, Corps of Engineers.

5.2 CONSTRUCTION DATA

The construction data reviewed were limited to:

(a) Several construction photographs showing the repairs performed in 1935.

(b) Several 1935 newspaper articles discussing the failure in 1935.

(c) A few progress reports over a period of several months discussing the general status of the construction work;

(d) A few "Memorandum Reports"; and

(e) Several miscellaneous letters and notes of correspondence pertaining to many aspects of construction.

5.3 OPERATION AND EVALUATION DATA

The most complete report available was written by Mr. A.R. O'Reilly, Chief Engineer, Bureau of Water, City of Reading, dated July 29, 1935, entitled "Report on Damage to Ontelaunee Dam". This report briefly describes the construction history and operational procedure during the flood. It also evaluates the damage due to the 1935 flood and suggests procedures to repair the structure. A description of the final repair procedure was not available.

6.0 RESULTS OF VISUAL INSPECTION

A composite of the significant observations and comments of the field inspection team is contained on the Checklist included in Appendix B.

In general, the impoundment and appurtenant structures appeared to be in good operating condition and a reasonable state of repair. Some minor cracking, spalling and leaching of concrete was observed in the pumphouse structure.

No sloughing, uncontrolled seepage or other symptoms of malfunction were noted along the downstream face or toe of the dam. Several small (3 to 4 foot diameter) sinkholes that had been recently filled, were noted to be located in the downstream area. In all cases there was no evidence of seepage emergence at or in the vicinity of the sinkhole location. It was reported that these sinkhole depressions develop routinely and are periodically filled with impervious materials by the City of Reading. Since water was flowing over the spillway during the inspection, the downstream channel and stilling basin could not be inspected for sinkholes.

At the time of inspection, the reservoir was at normal pool elevation and an inch or two of flow over the spillway crest was noted. The water supply intake lines appeared to be in normal operation and control valves in the pumphouse were exercised to test their serviceability. The inspection team was advised by the City Engineer that control valves at the bridge could not be exercised without procurement of machines to twist the valve stem. It is understood from the maintenance staff that machinery would be available during unusually heavy rainfall to open these valves.

The full length of the gallery was examined and all accessible shafts inspected. Leaching of the concrete was observed, otherwise, no unusual or malfunctioning conditions were detected.

7.0 OPERATIONAL PROCEDURES

There were no written operations procedures available during the inspection, but it is understood that the three intake control valves are adjusted in the pump-house as necessary to supply the filtration plant. It is also understood from the maintenance staff that routine maintenance, including sinkhole filling, is conducted as potentially hazardous conditions are observed. The inspection team was advised by the City Engineer that an under-water inspection of the spillway and four control valves was performed a few years ago and that valve stems were repaired at that time. During periods of extreme storms the dam is periodically checked by the maintenance/operating staff.

8.0 WARNING SYSTEM

The available data and on-site observations failed to identify any monitoring instrumentation or warning system in effect at the dam site. Conversations with local operating personnel indicated courses of action individuals might take under emergency conditions. However, no formal plan was identified which addresses a predetermined response to development of conditions potentially hazardous to the dam or life downstream.

9.0 HYDROLOGIC AND HYDRAULIC EVALUATIONS

The available hydrologic and hydraulic calculations made as part of the initial project design were found to be incomplete. Consequently, simplified approximate calculations, in accordance with OCE criteria, together with a review of historical performance data was used to provide an approximate assessment of the storm inflow vs. the capacity of the outlet works of the dam. Subsequently, a somewhat more refined analysis was performed as discussed below. At the time of this writing, two additional references were received [Section 5.1 (e) and (f)]and reviewed. Conclusions based on this recent data are incorporated in this evaluation.

Some design data was extracted from reports located in Pennsylvania State DER files. The character of the drainage area is described in the "Report Upon the Application", dated 1926 as follows:

> "Maiden Creek is one of the principal tributaries of the Schuylkill River, flowing into it near Ontelaunee Station on the Pennsylvania Railroad about seven miles north of Reading. Its total drainage area is 216 square miles, and is roughly a parallelogram with an average width of about 10 miles, the greater part being in Berks County, the northeastern section extending into Lehigh. The north section is mountains, sparsely settled down to about Evansville, below which the topography changes to a rolling open country. The fall from the divide to Evansville is 1370 feet in a distance of 18 miles, 1180 feet occurs the first two miles. The average slope of the creek bed between the foot of the mountain and Evansville is 10.1 feet/mile, while below the average slope is 5.9 feet/mile". "... considerable second growth timber in the northern mountainous portion. The limestone portion well suited for agriculture".

Latest USGS maps confirm the nature of the watershed and show it to be approximately 192 square miles in total area.

The reports on file indicate that the spillway was designed to pass the computed runoff from the 1902 storm of record, which produce an estimated runoff of 41,000 cfs. This storm was estimated by the designers to have a return period of 30 years and to produce a spillway discharge estimated to be approximately eight feet above spillway crest, leaving a 2.5 foot freeboard. The method of determining this return frequency was not documented. The storm of record (Hurricane Agnes, 1972) produced a peak head of 5.4 feet of water over the spillway crest, an estimated discharge of 24,000 cfs.

Because of the lack of readily available data for a state-of-the-practice evaluation, an approximate PMF was performed using two methods. The first method computed the peak inflow rate as a function of the drainage area size, as determined from criteria supplied by the Corps of Engineers. The time base, also estimated as a function of the drainage area size, was determined from the prescribed criteria. A triangular inflow hydrograph approximation and flood routing was then constructed according to instructions contained in the Corps of Engineers' "Preliminary Engineer Technical Letter, No. 1110-2", dated January 25, 1978. In the second flood routing performed, the peak inflow was determined as before, but the total volume under the hydrograph was set equal to a runoff of the first 24 inches, a much more compatible watershed characteristic than the 61 inches predicted by the first method. See notes in Appendix C.

Both methods indicated a spillway design flood (SDF) of less than one-half of the PMF. More recent studies [Section 5.1 (e) and (f)] performed directly on Maiden Creek show that the dam and spillway will just pass one-half PMF without overtopping. Regardless, the spilway capacity of Ontelaunee Dam does not meet the PMF hydrologic safety standard recommended by the Corps of Engineers' Phase I Dam Safety guidelines. This coupled with the potential for failure and excessive downstream damage classified the spillway as "Inadequate". The capacity of the spillway just before overtopping is estimated to be 65,000 cfs.

10.0 EVALUATION OF STRUCTURAL STABILITY

The long (45 year) history of satifactory performance is an indication that the design objectives of the dam and appurtenant facilities have been met. Further, no post-construction deterioration or operational changes were noted that suggest any significant reduction of the dam's as-built integrity.

Because the dam and reservoir are known to be located in an area of karstic limestone geology, the potential for sinkhole development is high, especially where the subsoils and rock are exposed to saturation and seepage flow induced by the reservoir. In recognition of this potential

problem, the concrete section of the dam was keyed into the foundation rock and a single line (5 feet on center) grout curtain was installed during construction. The lack of any known sinkhole development at this spillway suggests that the foundation rock, below normal pool elevation, is probably not conducive to solution activity. However, the downstream channel and stilling basin should be checked for evidence of sinkhole activity when the reservoir is below the spillway crest.

The foundation of the earth embankment section of the dam is not subject to significant hydraulic head during normal reservoir operation as the embankment serves as an impoundment dike only during periods of peak flow. The embankment foundation has, therefore, been under a significant head of water only a few times during its history. The first time the upstream toe of the embankment was flooded (1935), sinkholes were formed with resulting collapse of sections of the embankment. These holes have since been filled and grouted and the embankment replaced. Because of the infrequency with which this zone comes into service, and the high potential for sinkhole development in the soluable limestone foundation rock, there is no assurance that it will withstand the test of a higher head than that which it has previously experienced. Consequently, the stability of the earth embankment and the effect of an embankment break should be further evaluated. Similarly, a stability analysis of the spillway should be performed when the reservoir is at maximum storage elevation.

11.0 OVERALL ASSESSMENT

As described in Section 8.0, a formal plan to be used in response to the development of conditions hazardous to the dam has not been developed. Detailed hydrologic and hydraulic data, including up-to-date flood routing data are also lacking and are required to provide a rigorous assessment of flood inflow and dam outlet capacity, as well as the frequency of flood occurrence.

Consistent with the foregoing findings, it is recommended that additional engineering investigations be made to provide a detailed evaluation of the hydraulic and hydrologic features of the dam and to assess the stability

and consequence of failure of the embankment and spillway sections. Formal contingency plans should also be prepared commensurate with these findings.

12.0 REMEDIAL MEASURES

Based on the results of the visual inspection, review of the files and discussion with representatives of the City of Reading, it is recommended that a formal Operation and Maintenance Manual be formulated for this dam and reservoir. It should include a description, together with sample forms, for monitoring daily operation and pool levels. It should contain procedures for monitoring large forecasted storms and controlling the reservoir levels.

A regular inspection/surveillance program should be formalized which includes the exercising of all reservoir control valves. These valves should be kept in good operating condition and capable of being readily opened during a storm. Downstream conditions should be assessed to determine the possible limits of damage and threat to life that could be expected as a result of various storms. A formal warning system should also be installed and designed to notify appropriate personnel when the reservoir reaches a pre-determined critical level.

APPENDIX

A

NAME OF DAM *Ontelaunee Dam*

ID # *PA 00709*

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
AS-BUILT DRAWINGS	*None available but a set of 50 blueprint design drawings were available for review.*
REGIONAL VICINITY MAP	*"General Layout Plan" of Maiden Creek Improvements including Lake Ontelaunee, dated May, 1927, was available.*
CONSTRUCTION HISTORY	*Construction history was sparce but summarized in Mr. A.R. O'Reilly's report dated July 29, 1935, entitled "Report on Damage to Ontelaunee Dam".*
TYPICAL SECTIONS OF DAM	*These are available on the construction drawings.*
OUTLETS - PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	*Some scattered data was available from the Harrisburg files and is tabulated on the Hydrologic/Hydraulic analysis form enclosed in the Appendix.*
RAINFALL/RESERVOIR RECORDS	*Time was not available to collect all of these records.*

ITEM	REMARKS
DESIGN REPORTS	*There were no design reports in the files for review but there were a few letters, applications reports and miscellaneous correspondence discussing stability, seepage, geology and very little on hydrology.*
GEOLOGY REPORTS	*The rock beneath the spillway and embankment is identified as the Beakmantown Group. Exposures at the toe of the spillway and along the right bank of the channel indicate a dolomitic rock which is probably part of the Rickenback Formation. The rock is fine to coarsely crystalline and contains beds of chert. The bedrock surface is karstic and solution features developed along the joints and fractures of the rock.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	*The files did not contain design computations but did have one summary for the spillway stability and application reports contained statements concerning spillway capacity and hydrologic criteria. In addition, a report dated July 29, 1935, by A.R. O'Reilly, Chief Engineer, Bureau of Water, discussing the seepage and failure of the dam as the result of sinkhole development was available and reviewed.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*Some (very few) field investigation records were available for review.*
POST-CONSTRUCTION SURVEYS OF DAM	*None*
BORROW SOURCES	*Location could not be determined.*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	
HIGH POOL RECORDS	*Hurricane Agnes (1972) records were available.*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*Report entitled, "Report on Damage to Ontelaunee Dam" dated July 29, 1935, was available for review.*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*Same as above.*
MAINTENANCE OPERATION RECORDS	*Operation records are maintained and were reviewed but there was not enough time to formulate a summary of these records. Maintenance records are not maintained at the site.*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*Plans were available for review.*
OPERATING EQUIPMENT PLANS & DETAILS	*Plans were available for review.*

APPENDIX

B

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Ontelaunee Dam* **County** *Berks* **State** *Pennsylvania* **National ID #** *PA 00709*

Type of Dam *Earth with Concrete Overflow Section* **Hazard Category** *I (High)*

Date(s) Inspection *April 4, 1978* **Weather** *Cool-Cloudy Occas. rain in a.m.* **Temperature** *35° to 50°F*

Pool Elevation at Time of Inspection *294.1* **City Datum** **Tailwater at Time of Inspection** *258±* **City Datum**

NOTE: City datum is 10.271 feet above U.S.G.S. datum as per Application Report (6/21/26).

Inspection Personnel:

Vince McKeever (Hydrologist)	*David Chou (Structural)*	*John H. Frederick (Geotechnical)*
Mary Beck (Hydrologist)	*Ray Lambert (Geologist)*	
Noel Ravneberg (Geologist)		

John Boschuk, Jr. (Geotechnical) **Recorder**

Remarks:

Other persons at this inspection included: Mr. George C. Patton, Engineer for the City of Reading, Bureau of Water; Messrs Howard Koch and Dan Kennedy, City of Reading; Mr. Edward Leonardzak, City Councilman, City of Reading.

CONCRETE

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

ANY NOTICEABLE SEEPAGE *Since the reservoir was flowing over the entire spillway, seepage could not be observed on the spillway runs. Seepage stains were observed along the downstream retaining wall on the right abutment along the second and third horizontal joints. Traces of seepage were observed through the horizontal joints along the downstream left abutment retaining walls and appeared to be very old continuous seeps. This seepage confirms a 3/8/46 inspection report.*

STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS *The expansion joint between the pump house and the bridge was connected with steel on the upstream side of the bridge. This concrete was cracked at that end and portions of the rebar along the u/s right abutment of the bridge were exposed.*

DRAINS *None observed.*

WATER PASSAGES *N/A*

FOUNDATION *All foundations were buried or covered with water and could not be inspected.*

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*Cracks on the upstream face seem to be located in the upper third of the dam. However, another inspection should be conducted when the water level is lowered sufficiently to facilitate a more thorough inspection.*	
STRUCTURAL CRACKING	*At the east embankment concrete wall - several veritical but mostly horizontal cracks were observed. Structural cracks were visible in the walls and slab of the pump house and appeared to be old and stable.*	
VERTICAL AND HORIZONTAL ALIGNMENT	*Visual inspection of the dam crest alignment showed no signs of vertical or horizontal movement.*	
MONOLITH JOINTS	*Monolith joints of the dam spillway could not be inspected because the spillways were flowing.*	
CONSTRUCTION JOINTS	*In the inspection gallery, the construction joints are in good condition although there was water seeping through a few of them. In the gallery and stairwell to the gallery, seepage produced leachate of calcite which crystallized on the walls and formed stalactites on the gallery ceiling. Construction joints in the downstream wing walls and at walls supporting the observation platform indicate deterioration and slight movement of the wall.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*There were no surface cracks observed in the embankment.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*There were no signs of slope movement at or beyond the toe on the downstream side or the exposed portions of the toe on the upstream side. Slope repairs associated with the filling of sinkholes on the downstream toe were observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*Slight slope erosion was observed on the downstream side in a few isolated locations as a result of concentrated run-off from the highway constructed over the dam embankment. It was reported by the park manager that these gullies (as shown on Photo 5) are routinely repaired by the Owner. Several depressions were visible on both sides of embankment. The depressions appear to correspond with sinkholes mapped 7/12/35 and 12/10/37. Recent filling of sinkholes (depressions) were evident at the time of the inspection.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*There were no signs of significant vertical or horizontal movements of the embankment.*	
RIPRAP FAILURES	*No failures or significant distorsions were observed.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*Right Abutment:* This abutment contains the pumphouse on the upstream side and an observation platform on the downstream side. There were no observed signs of separation movement or seepage at this juncture. *Left Abutment:* This junction between the spillway wall and embankment showed no signs of movement, but seepage was observed through the horizontal joints of the downstream wing wall. Joint deterioration was observed and photographed.	
ANY NOTICEABLE SEEPAGE	There was no seepage observed through the embankment.	
STAFF GAGE AND RECORDER	Staff Gage is a Bristol Recorder - Model 1KC500-15, series 807050. It is checked by the owner on week days and the equipment which appeared to be functioning during the inspection, produces a weekly chart.	
DRAINS		

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*N/A*	
INTAKE STRUCTURE	*This structure is underwater and could not be inspected.*	
OUTLET STRUCTURE	*City water supply outlet pipe is buried and could not be inspected.*	
OUTLET CHANNEL	*N/A*	
EMERGENCY GATE	*None - Ungated over-flow spillway.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS

CONCRETE WEIR *Water was flowing over the ungated spillway and could not be inspected. However, the water was flowing smoothly and uniformly indicating that no severe distorsions or dislocations existed along the crest. The total distance measured between abutments was 543.3 feet with six 6-foot piers for bridge support. Therefore, the net spillway length is (543.3-36.0) = 507.3 feet.*

APPROACH CHANNEL *N/A*

DISCHARGE CHANNEL *Since the channel was underwater, an inspection of the apron could not be performed.*

BRIDGE AND PIERS *As observed from the observation platform, there were no visible signs of distress observed on the bridge and piers. However, portions of the roadway do need repair where deterioration is probably associated with the past two severe winters.*

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*No instrumentation.*	
OBSERVATION WELLS	*No instrumentation.*	
WEIRS	*No instrumentation.*	
PIEZOMETERS	*No instrumentation.*	
OTHER	*None.*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*All slopes appeared to be moderate and stable.*	
SEDIMENTATION	*Upper ends of the reservoir have moderate accumulation of sediment which does not affect flood storage capacity above mean normal pool.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*No debris or obstructions were observed in the channel except for low-head dam 1/2± mile downstream. Trees are growing in the flood plain which gently slopes upward on the left side. The area to the left of the channel, which is approximately 500 ft. wide and 2,000 ft. long, is wet with ponded water. On the right side the slope is 2:1 with timber throughout. The main channel is approximately 150 ft. wide.*	
SLOPES	*All slopes are tree covered.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*Population is 210 according to state inventory form along the 2½ miles to the Skuylkill River which would be subject to flooding in case of a dam failure. According to the 1968 U.S.G.S. maps, 67 houses sit along the Schuylkill for 3½ miles below Maiden Creek to River View Park which would be subject to flooding. Many homes and businesses would be flooded in case of failure.*	

APPENDIX
C

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *192 square miles of rural drainage*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *Elevation 294*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *Elevation 302*

ELEVATION MAXIMUM DESIGN POOL: ______

ELEVATION TOP DAM: *304.5 but profile varies*

CREST:

a. Elevation *294.0 top of spillway*

b. Type *Earth dam with masonry concrete spillway*

c. Width *37± feet (width of earthen dam section)*

d. Length *3300*

e. Location Spillover *adjacent to right abutment (west side)*

f. Number and Type of Gates *None - open spillway*

OUTLET WORKS:

a. Type *Ogee spillway without gates*

b. Location *adjacent to dam right abutment*

c. Entrance inverts *294 top of spillway*

d. Exit inverts *N/A*

e. Emergency draindown facilities *5 blow off pipes (4-36" and 1-48") and 3 water supply intake pipes (3-48")*

HYDROMETEOROLOGICAL GAGES:

a. Type *None*

b. Location *None*

c. Records *None*

MAXIMUM NON-DAMAGING DISCHARGE: *Discharge rate not estimated. Out of channel flow will produce damage to properties built adjacent to channel.*

DAM SAFETY ANALYSIS
HYDROLOGIC/HYDRAULIC DATA

Date: 4/20/78
By: MFB
Sheet: 2 of 9

DAM Lake Ontelaunee Nat. ID No. PA 00709 DER No. 6-350

	ITEM/UNITS	Permit/Design Files (A)	Calc. from Files/Other (B)	Calc. from Observations (C)
1.	Min. Crest Elev.	304.5 ft.		
2.	Freeboard			0
3.	Spillway (1) Crest Elev.	294.0 ft.	293.8 ft.	
3a.	Secondary Crest Elev.	N/A		
4.	Max. Pool Elev.	302.0 ft		304.5 ft.
5.	Max. Outflow (2)			65,000 cfs
6.	Drainage Area	192 mile²		192 mile²
7.	Max. Inflow	40,896 cfs		
8.	Reservoir Surf. Area	1082 Ac.		1037 Ac
9.	Flood Storage (3)			10,888 Ac-Ft.
10.	Inflow Volume			

Reference all figures by number or calculation on attached sheets:

Example: 3A - Drawing No. xxx by J. Doe, Engr., in State File No. yyyy.

NOTES:

(1) Emergency spillway.

(2) At maximum pool, without freeboard.

(3) Between spillway and maximum pool (See Sheet 4)

Date: 4/20/78
By: MFB
Sheet: 3 of 9

HYDROLOGIC/HYDRAULIC CALCULATIONS (cont.)

Item (from page 2)	Source
1A	Plan, Earth Portion of Ontelaunee Dam, Dated Jan. 1934
3A, 4A	Plan, Maximum Section for Ontelaunee Dam, Dated May 1926
6A	Map of Drainage Areas of Streams now supplying Water to Reading, Dated May 1926
7A, 8A	Application Report, dated June 21, 1926
3B	Report on Damage to Ontelaunee Dam, Dated July 29, 1935
6C, 8C	USGS Maps Temple (1968) Hamburg (1969) New Ringold (1969) Fleetwood (1969) Kutztown (1974) New Tripoli (1969) Slatedale (1972) Matatawny (1973) Topton (1972)
4C	Top of Dam
5C	See sheet 6 of 9

DAM SAFETY ANALYSIS
HYDROLOGIC/HYDRAULIC CALCULATIONS

Date: 4/4/78
By: VM / MFB
Sheet: 4 of 9

DAM Lake Ontelaunee Nat. ID No. PA 00709 DER No. 6-350

Calculations for *Design* [ ], *As-Built* [ ], *Existing* [✓] Conditions

1. Spillway Discharge at Max. Pool*, Q_{omac} 65,000 cfs effective weir length = 504; c = 3.79 (assumed)
   Freeboard at Max. Pool 0 ft.

2. Tributary Drainage Area*, A 192 mi²

3. From Corps Curves:
   a) Inflow hydrograph peak flow, Q_{Imax} 157,440 (78,720) cfs at 100% (50%) PMF
   b) Inflow hydrograph duration, T 96 hrs.

IF Q_{omax} exceeds Q_{Imax}, check here and stop [ ]

4. Calculate $p = Q_{omax}/Q_{Imax}$ = 65,000/157,440 (65,000/78720) = 0.4128 (0.8257).

5. Calculate Volume of inflow hydrograph, V_I

   $V_I = 1800\ Q_{Imax}\ T$ = 1800 x 157,440 x 96 = 624,555 ~~ft³~~ Ac-Ft (312,278 Ac-Ft)

6. Calculate volume of storage between normal and maximum pool, V_s

Crest Elevation	=	304.5	ft.
Freeboard**	=	0	ft.
El. Max. Pool	=	304.5	ft.
El. Normal Pool**	=	294.0	ft.
Storage Height	=	10.5	ft.

Area of reservoir from USGS quad sheet*, 1037 Ac.

V_s = Storage Height x Area = 10,888 Ac-Ft.

IF V_s exceeds V_I, check here and stop [ ].

---

* *See Sheet 2*

** *Attach justification for values selected.*

HYDROLOGIC/HYDRAULIC CALCULATIONS (cont.)

DAM *Lake Ontelaunee*

Design [ ], *As-Built* [ ], *Existing* [✓]

Date: 4/4/78

By: VM / MFB

Sheet: 5 of 9

7. Calculate storage required to pass flood, V_R

$$V_R = (1-p)\ V_I = (1 - 0.4128) \times 624555 = \frac{366{,}700}{(54{,}426)} \text{ Ac-Ft.}$$

IF V_S exceeds V_R, check here and stop [ ].

8. Calculate freeboard storage, V_F

$$V_F = \text{Freeboard} \times \text{Area} = \_\_\_\_ \times \_\_\_\_ = 0 \text{ ft}^3$$

Does V_R exceed $V_S + V_F$? yes. If yes, repeat for 1/2 PMF, if this calculation is for 1/2 PMF, and answer is still yes, dam may be unsafe.

SUMMARY

Dam passes	PMF with ________ ft. freeboard . . .	[ ]
	PMF with no freeboard	[ ]
	1/2 PMF with ________ ft. freeboard .	[ ]
	1/2 PMF with no freeboard	[ ]
	None of the above	[✓]

The above PMF volume results from a run-off of 60.99 inches.(1)

A PMF rainfall (from Hydrometeorological Report No. 33) ~ 24 inches.

50% PMF can be no greater than 12 inches

$$V_I = \frac{12}{12} \cdot 192 \cdot 640 = 122{,}880 \text{ Ac-Ft.}$$

$$V_R = \left(1 - \frac{65{,}000}{78720}\right) 122{,}880 = 21{,}420 \text{ Ac-Ft} > V_S = 10{,}880 \text{ Ac-Ft}$$

(1) This PMF value is inconsistent with the generally accepted PMF values as determined from Hydrometeorological Report No. 33. However, the peak inflow rate, Q_{Imax}, computed using the supplied curves is fairly consistent with other conventional methods of determination. Therefore, the same approximate flood routing procedure using the same Q_{Imax} and a reduced V_I (as determined from Hydromet 33) was performed. See Sheet 6 of 9 also.

Lake Ontelaunee Watershed

Drainage Area = 192 sq. miles

Peak Inflow from C of E curves (Q_I)

Q_I = 820 cfs/mile² x 192 mile² = 157,440 cfs @ PMF

Time Base of Inflow Hydrograph (from curve)
= 96 hr.

Inches of Runoff - assuming triangular inflow hydrograph

$$= \frac{1}{2} \cdot \frac{157{,}440 \text{ cfs}}{192 \text{ mile}^2} \cdot \frac{3600 \text{ sec}}{640 \frac{\text{Ac}}{\text{mile}} \text{ hr}} \cdot \frac{96 \text{ hr}}{43560 \frac{\text{ft}^2}{\text{Ac}}} \cdot \frac{12 \text{ in}}{\text{ft}}$$

= 40.99 inches of runoff
(High)

Lake Ontelaunee Spillway Discharge

Estimate Effective Length L

$L = L' - 2\, K_a\, H_e$ (ref. Design of Small Dams. p. 373)

L' = Total Length = 543.5 - 6 x 6 (piers of bridge)
= 507.5

K_a = Abutment Contraction Coefficient
= 0.2

H_e = Total Head on Crest
= 8 ft. (orginal design head (max.))

$L = 507.5 - 2 \cdot 0.2 \cdot 8 = 504.3$ - say $\underline{504 \text{ ft}}$

Assume C = Coefficient of Discharge
= 3.79 and is Constant

Maximum Discharge $Q = CLH^{3/2}$ for H = 10.5 ft
$= 3.79 \cdot 504 \cdot 10.5^{3/2}$
= 64,991 cfs
SAY 65,000 cfs

Maiden Creek Reservoir - located above Ontelaunce Dam

Drainage Area = 161 sq. miles

Spillway Design Flood (PMF) Inflow Hydrograph

Peak Inflow = 117,500 cfs

Runoff = 23.4 inches - 48 hr storm
(above information supplied by OCE)

Assume Peak Inflow Proportional to Drainage Areas

Q_I = Peak Inflow to Lake Ontelaunce Reservoir

$= \frac{192}{161}\ 117{,}500$

= 140,124 cfs at PMF
(70,062) (0.5 PMF)

V_I = Inflow Volume to Lake Ontelaunce Reservoir

$= \frac{23.4}{12}\ 192\,\text{mile}^2\ 640\,\frac{\text{Ac}}{\text{mile}^2}$

= 239,616 Ac-Ft at PMF
(119,808) (0.5 PMF)

CONCLUSION: USE ABOVE Q_I AND V_I

DAM SAFETY ANALYSIS
HYDROLOGIC/HYDRAULIC CALCULATIONS

Date: 5/26/78
By: MFB
Sheet: 8 of 9

DAM Lake Ontelaunee Nat. ID No. PA 709 DER No. 6-350

Calculations for *Design* [ ], *As-Built* [ ], *Existing* [✓] Conditions

1. Spillway Discharge at Max. Pool*, Q_{omac} 65,000 cfs
   Freeboard at Max. Pool 0 ft.

2. Tributary Drainage Area*, A 192 mi^2

3. From Corps Curves:
   a) Inflow hydrograph peak flow, Q_{Imax} 70,062 cfs at 0.5 PMF
   b) Inflow hydrograph duration, T — hrs.

IF Q_{omax} exceeds Q_{Imax}, check here and stop [ ]

4. Calculate $p = Q_{omax}/Q_{Imax}$ = 65,000/70,062 = 0.9277.

5. Calculate Volume of inflow hydrograph, V_I

   V_I = ~~1800 Q_{Imax} T = 1800 x ______ x ______~~ = 119,808 Ac-Ft

6. Calculate volume of storage between normal and maximum pool, V_s

   Crest Elevation = ______ ft.
   Freeboard** = ______ ft.
   El. Max. Pool = ______ ft.
   El. Normal Pool** = ______ ft.
   Storage Height = ______ ft.

   Area of reservoir from USGS quad sheet*, 1037 Ac

   V_s = Storage Height x Area = 10,888 Ac-Ft.

IF V_s exceeds V_I, check here and stop [ ].

* *Attach calculations or source.*
** *Attach justification for values selected.*

HYDROLOGIC/HYDRAULIC CALCULATIONS (cont.)

DAM ______________________

Design /_/, *As-Built* /_/, *Existing* /✓/

Date: 5/26/78
By: MFB
Sheet : 9 of 9

7. Calculate storage required to pass flood, V_R

$$V_R = (1-p)\ V_I = \underline{(1-.9217)} \times \underline{119,808} = \underline{8656}\ \text{Ac-Ft}$$

IF V_S exceeds V_R, check here and stop /✓/ .

8. Calculate freeboard storage, V_F

$$V_F = \text{Freeboard} \times \text{Area} = \_\_\_\_\_\_ \times \_\_\_\_\_\_ = \_\_\_\_\_\_\ ft^3$$

Does V_R exceed $V_S + V_F$? _________. If yes, repeat for 1/2 PMF, if this calculation is for 1/2 PMF, and answer is still yes, dam may be unsafe.

SUMMARY

Dam passes	PMF with _______ ft. freeboard . . .	/_/
	PMF with no freeboard	/_/
	1/2 PMF with ________ ft. freeboard .	/✓/
	1/2 PMF with no freeboard	/_/
	None of the above	/_/

APPENDIX

D

VIEW OF LEFT ABUTMENT SPILLWAY RETAINING WALL LOOKING UPSTREAM.
NOTE SEEPAGE THROUGH THE JOINTS.

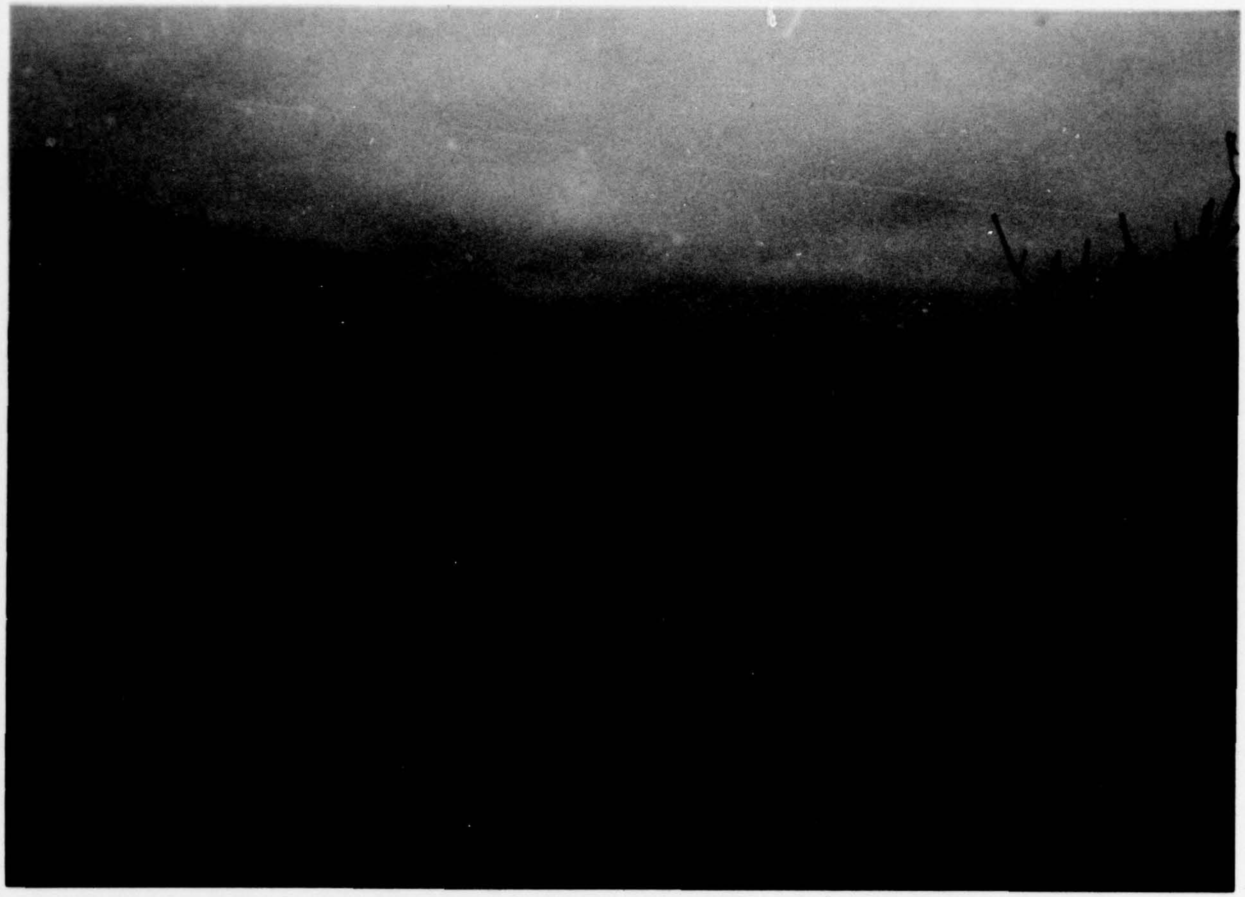
PHOTO NO. 1

VIEW OF SOIL FILLED SINKHOLE DEPRESSIONS ALONG THE DOWNTREAM TOE OF THE EMBANKMENT NEAR THE LEFT ABUTMENT OF SPILLWAY. THIS PHOTO IS TYPICAL OF SINKHOLE DEPRESSIONS OBSERVED.

PHOTO NO. 2

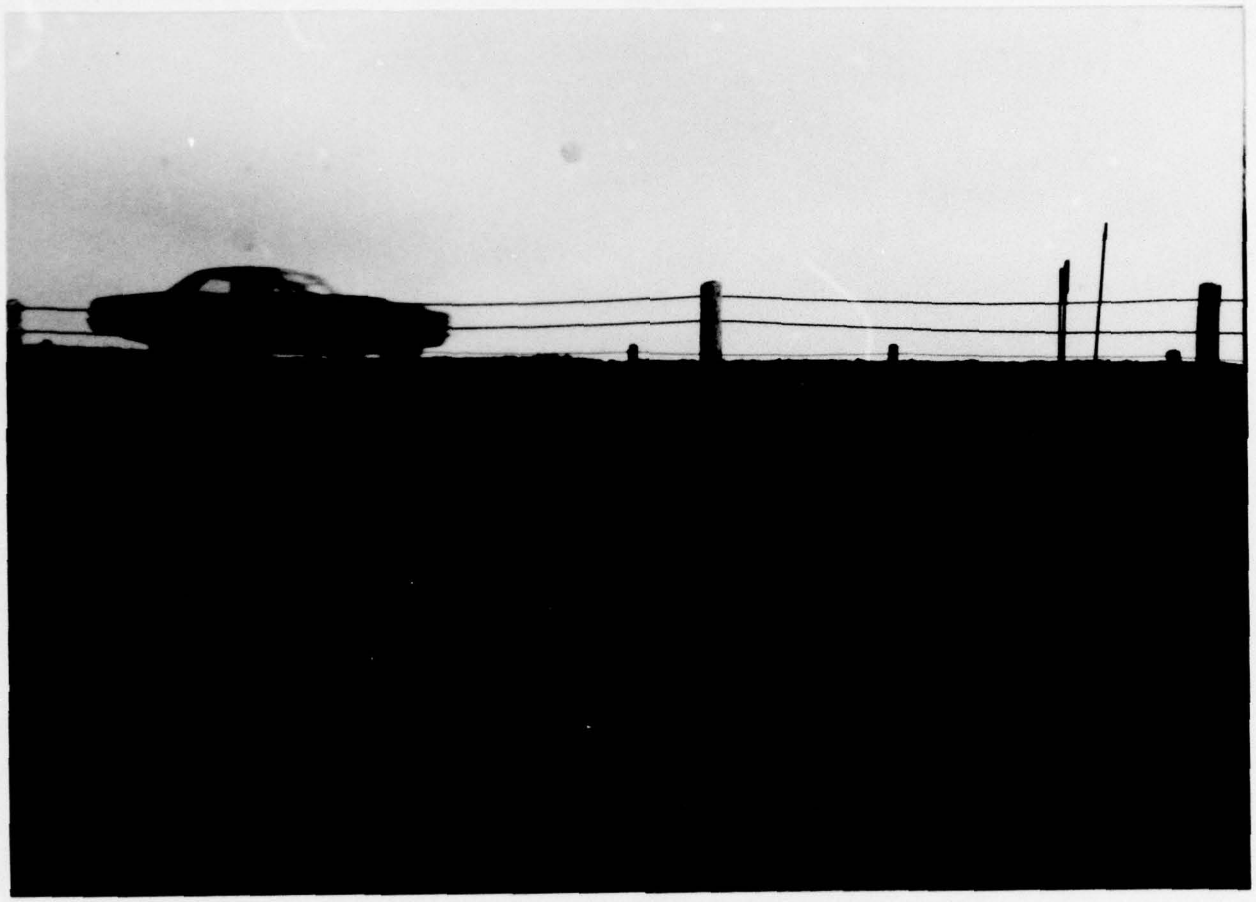
VIEW FROM ROADWAY LOOKING TOWARDS THE SPILLWAY.
WATER FLOW OVER THE DAM WOULD ENTER THE WOODS
AND TRAVEL WEST TOWARDS THE SPILLWAY.

PHOTO NO. 3



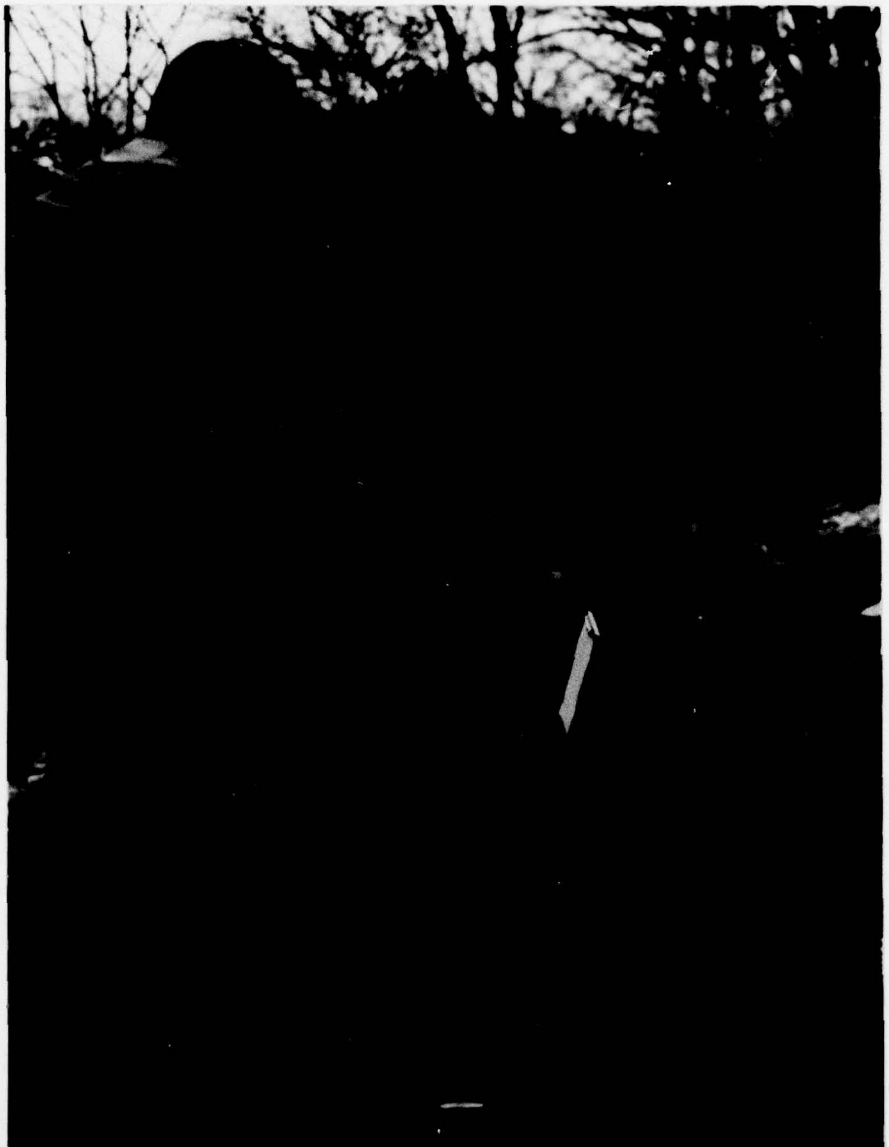
VIEW LOOKING EAST AWAY FROM THE SPILLWAY.
NOTE THAT THE NORMAL WATER ELEVATION DOES NOT IMPINGE ON THE EMBANKMENT.

PHOTO NO. 4



VIEW FROM THE DOWNSTREAM TOE.
NOTE THE DEVELOPMENT OF EROSION GULLY AS A RESULT
OF CONCENTRATED ROADWAY RUNOFF.

PHOTO NO. 5

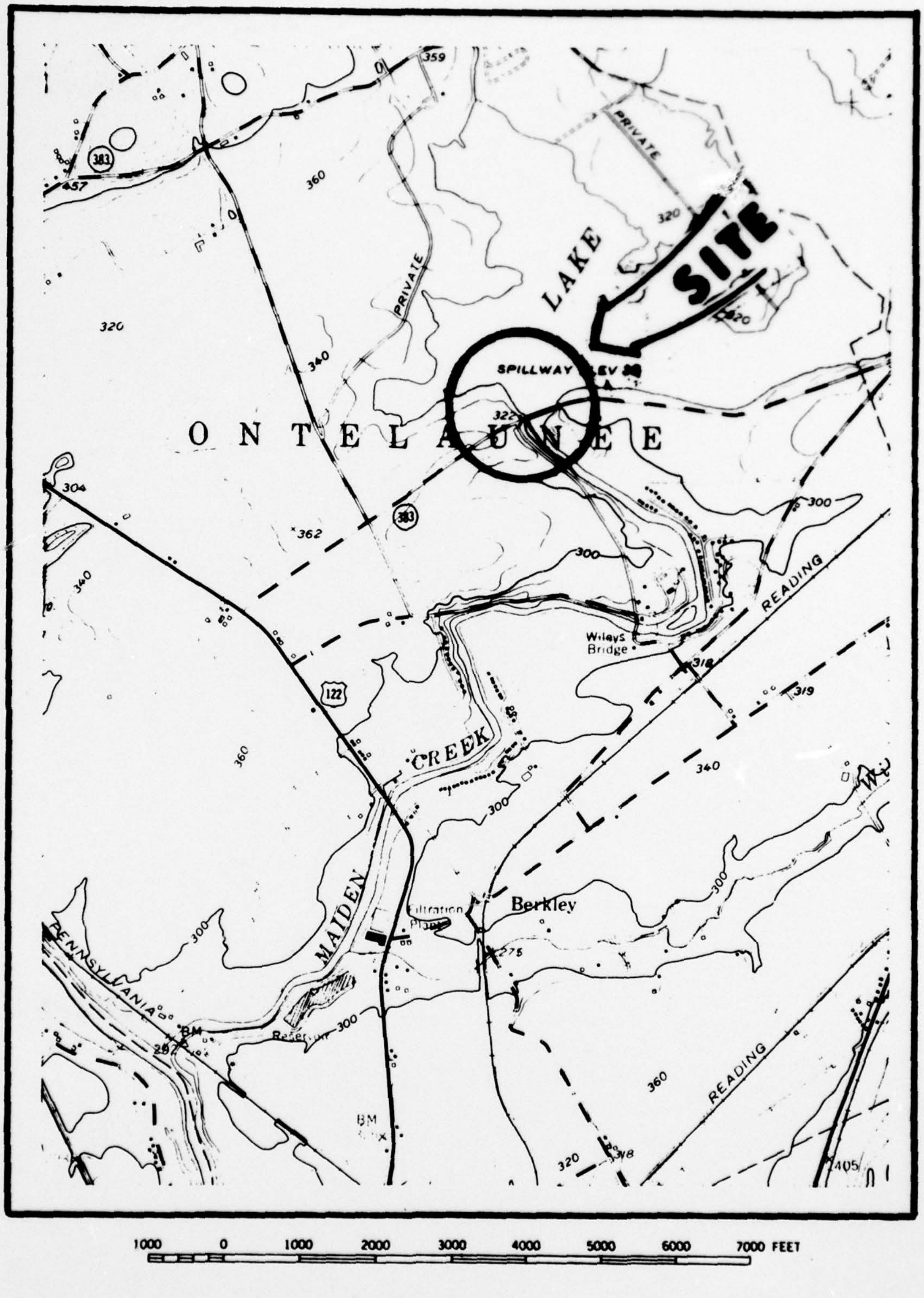


OUTCROP OF RICKENBACH DOLOMITE NEAR THE LEFT ABUTMENT.
BEDDING STRIKES N 70°E AND DIPS 85°S.
VIEW IS TO THE EAST.

PHOTO NO. 6

APPENDIX

E



REGIONAL LOCATION PLAN
LAKE ONTELAUNEE
U.S.G.S. QUAD SHEET 'TEMPLE'

PLATE 1

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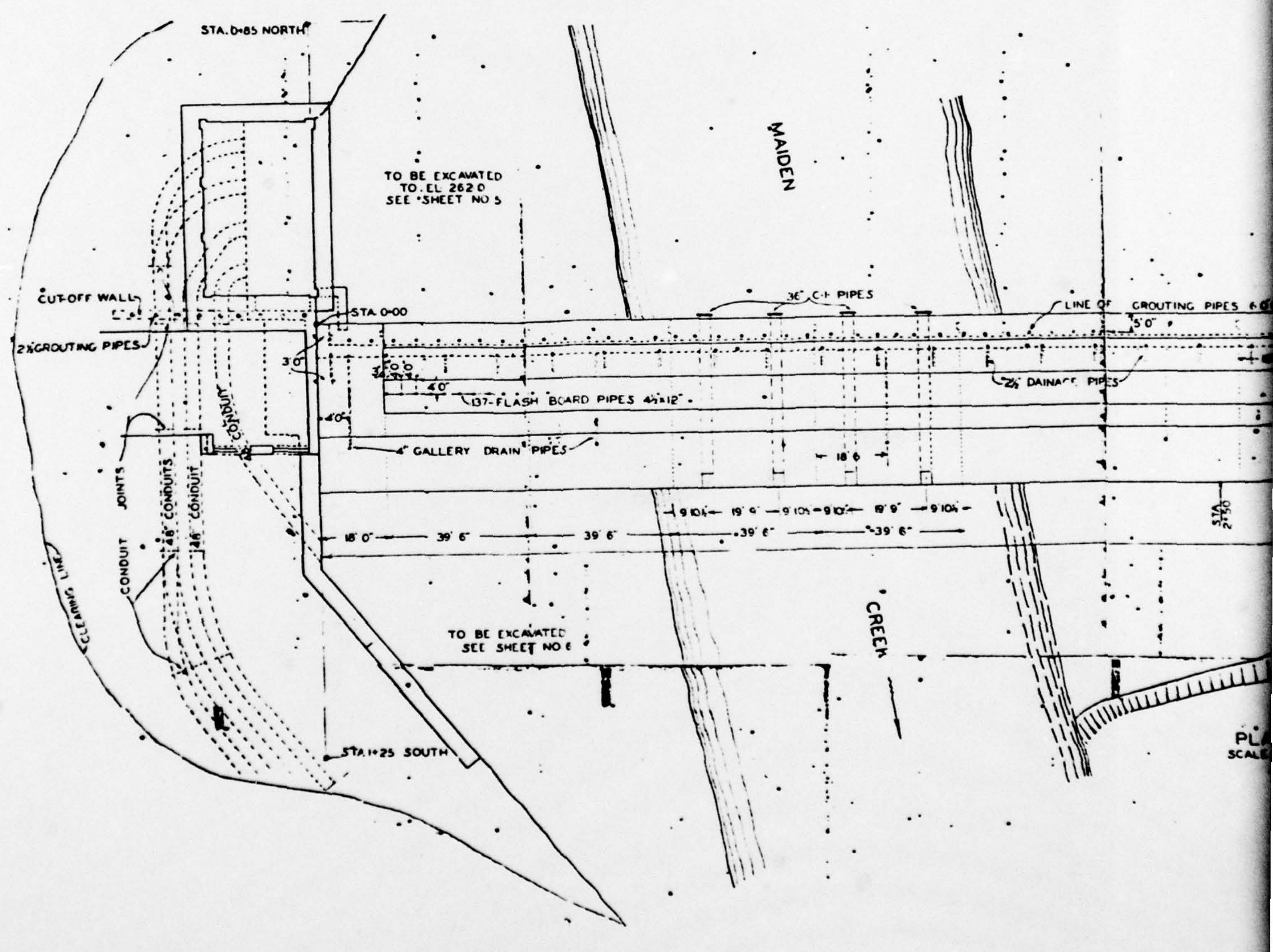

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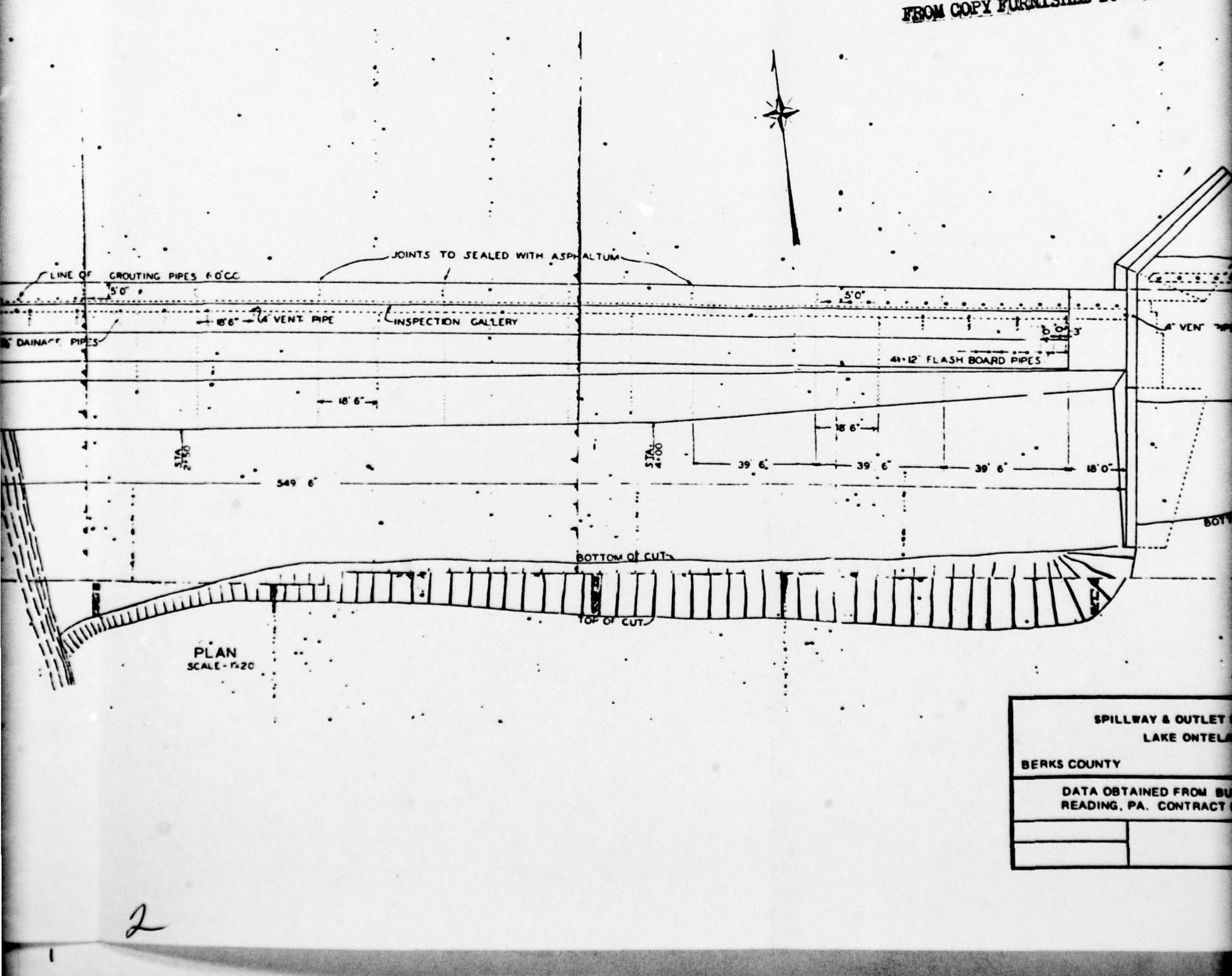

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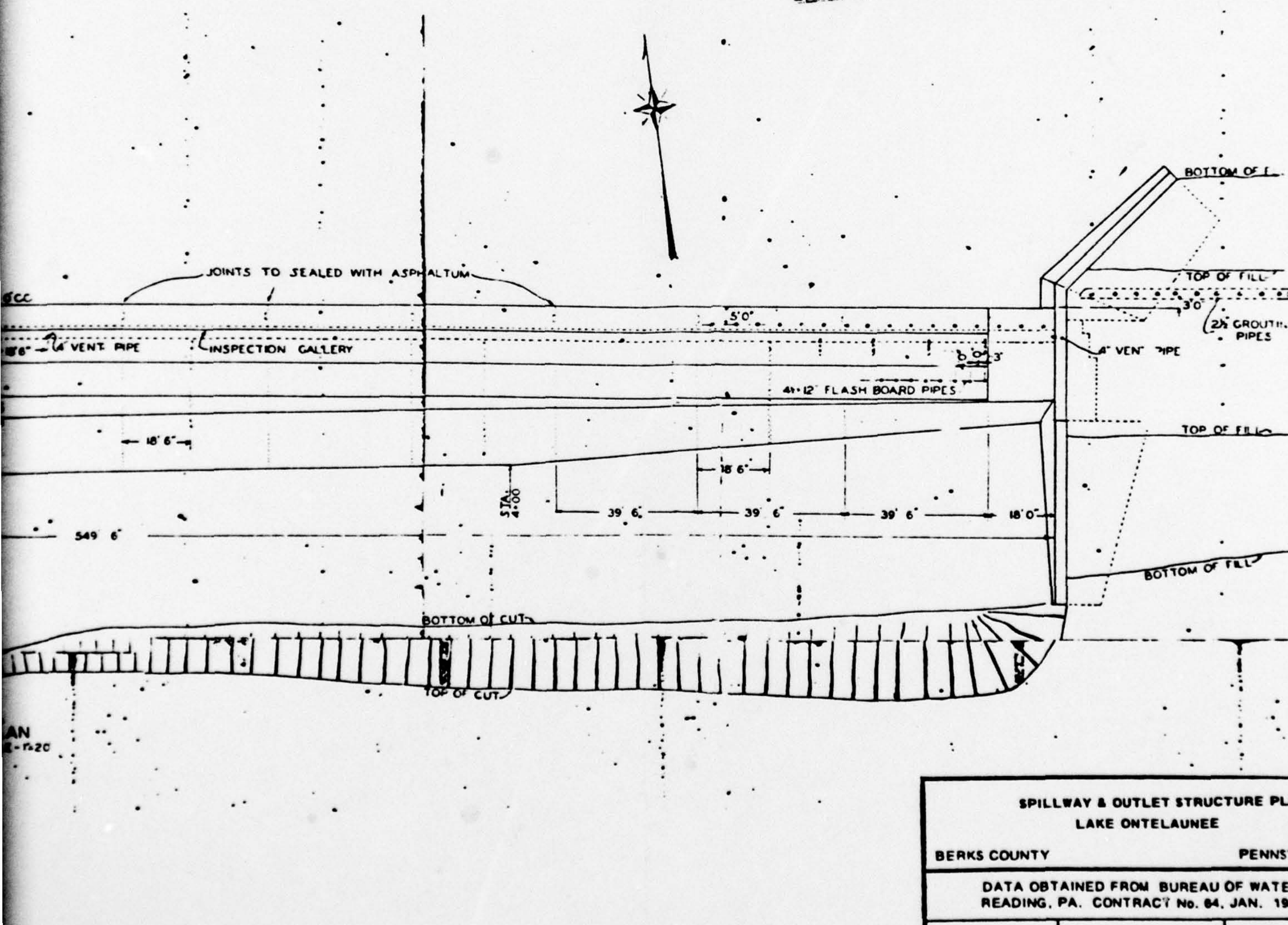
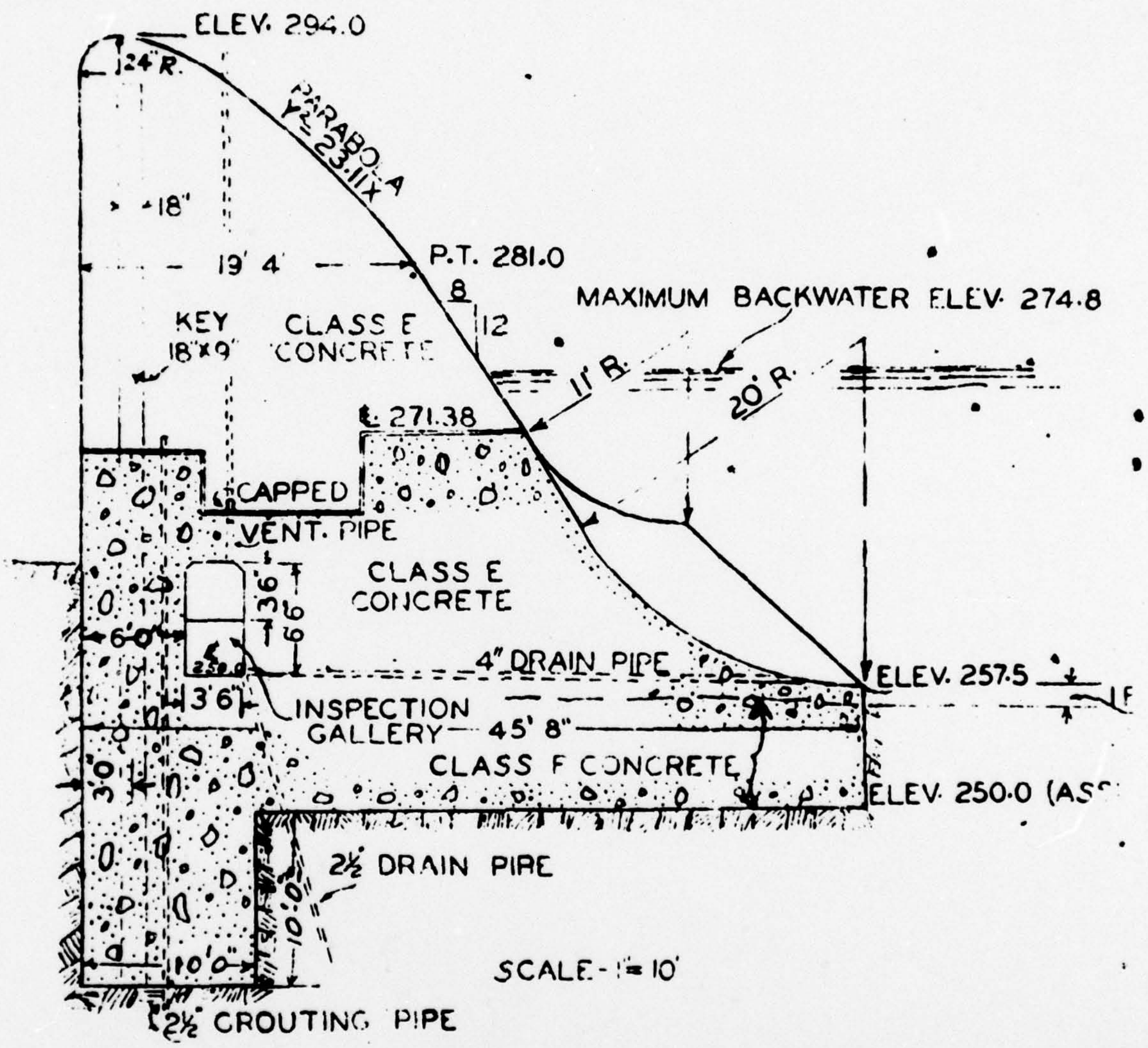


SPILLWAY & OUTLET STRUCTURE PLAN LAKE ONTELAUNEE	
BERKS COUNTY	PENNSYLVANIA
DATA OBTAINED FROM BUREAU OF WATER. READING, PA. CONTRACT No. 64, JAN. 1934	
	PLATE 2

3

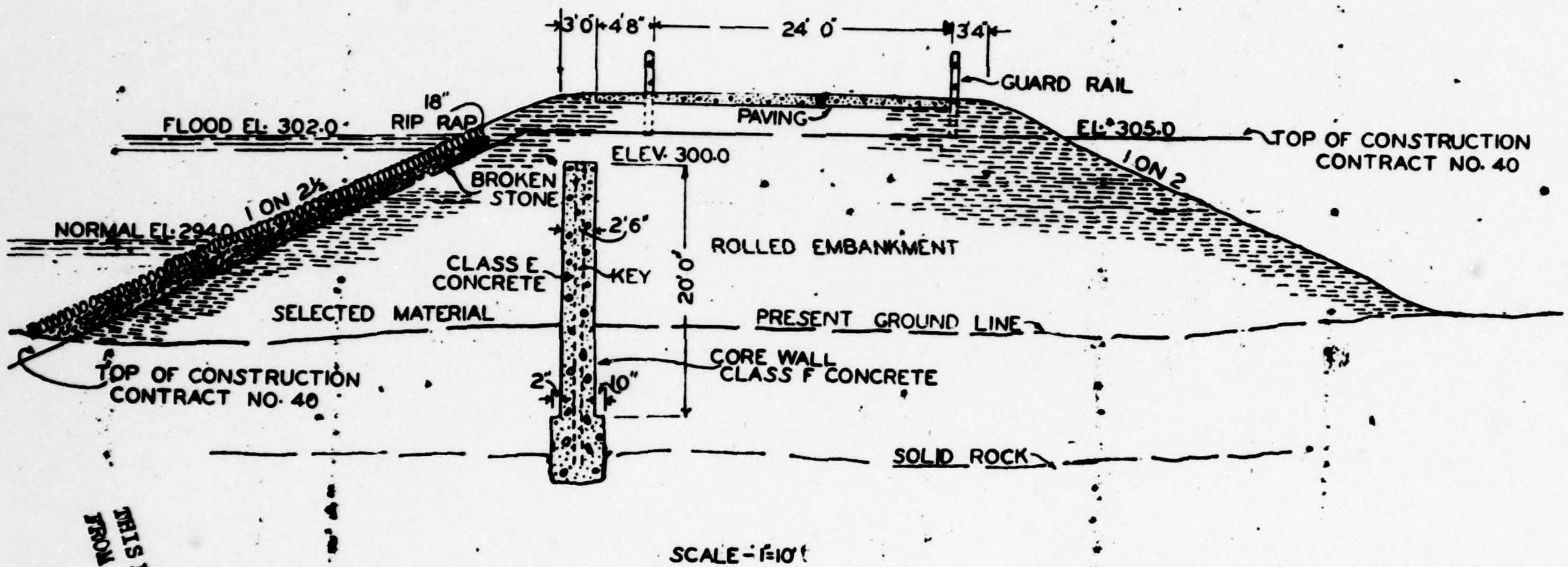


TYPICAL SPILLWAY SECTION
LAKE ONTELAUNEE

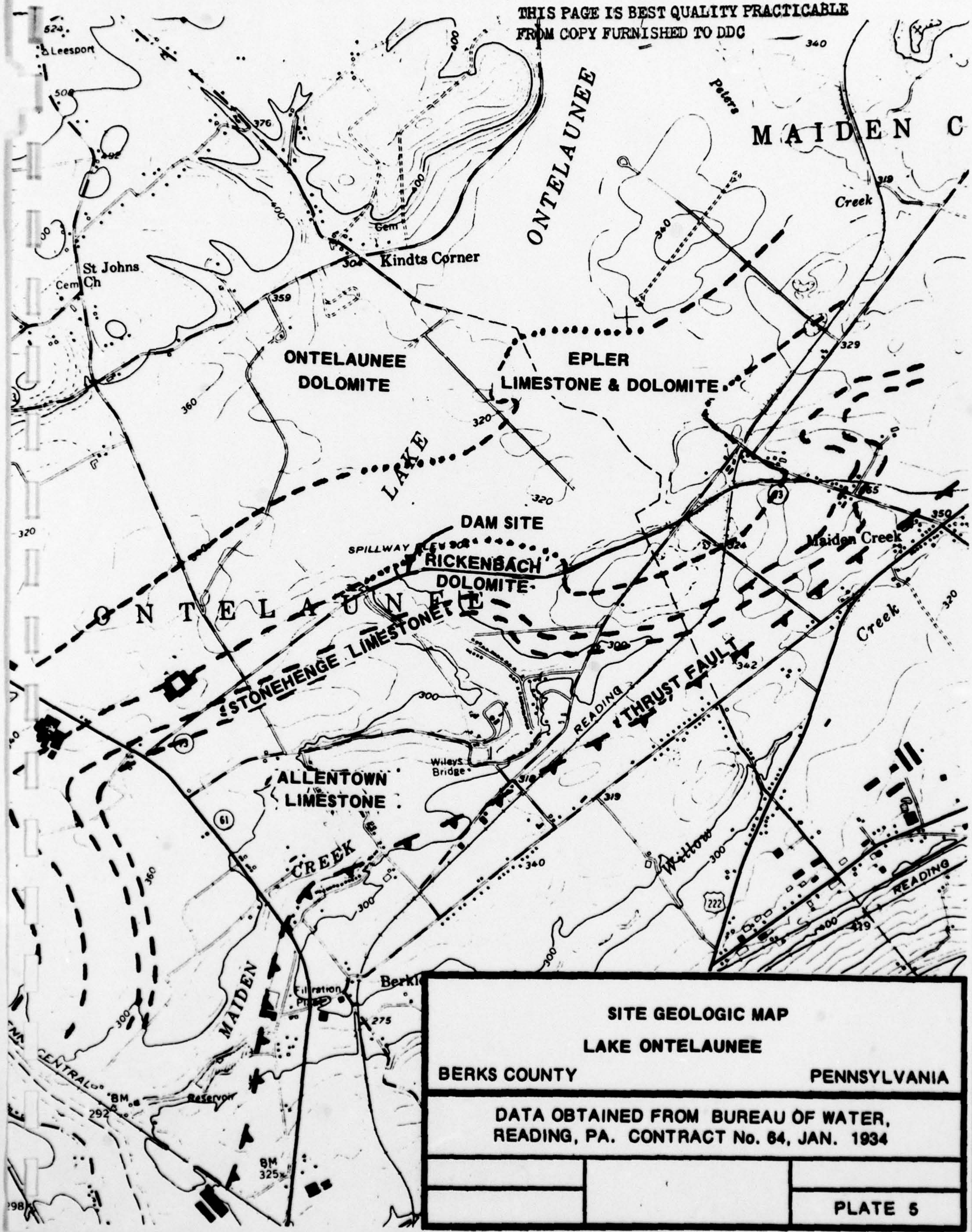
BERKS COUNTY PENNSYLVANIA

DATA OBTAINED FROM BUREAU OF WATER, READING, PA. CONTRACT No. 64, JAN. 1934

PLATE 3



TYPICAL EMBANKMENT SECTION LAKE ONTELAUNEE BERKS COUNTY PENNSYLVANIA		
DATA OBTAINED FROM BUREAU OF WATER, READING, PA. CONTRACT No. 64, JAN. 1934		
		PLATE 4


SITE GEOLOGIC MAP
LAKE ONTELAUNEE
BERKS COUNTY
PENNSYLVANIA
DATA OBTAINED FROM BUREAU OF WATER,
READING, PA. CONTRACT No. 64, JAN. 1934
PLATE 5
ONTELAUNEE DOLOMITE
EPLER LIMESTONE & DOLOMITE
DAM SITE
SPILLWAY
RICKENBACH DOLOMITE
STONEHENGE LIMESTONE
THRUST FAULT
ALLENTOWN LIMESTONE
ONTELAUNEE
LAKE
MAIDEN C
Peters
Creek
Maiden Creek
Creek
CREEK
MAIDEN
Willow
READING
CENTRAL
Leesport
St Johns Ch
Cem
Kindts Corner
Gem
Wileys Bridge
Filtration Plant
Reservoir
Berkl
BM 292
BM 325
222
61